

Environmental assessment of a biorefinery concept for production of bulk and fine chemicals

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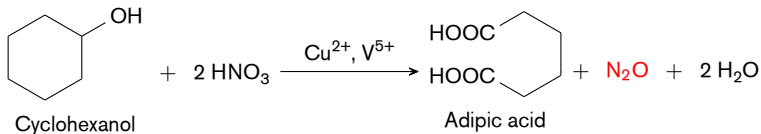
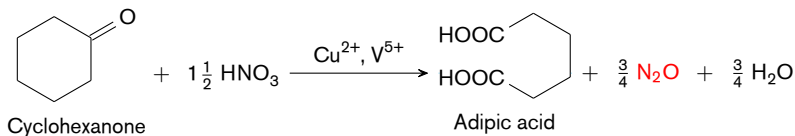


Outline

- 1 The case for bio-based adipic acid production
- 2 Set-up of the systems analysis
- 3 Environmental impacts of the biorefinery concept
- 4 Lessons learned from the analysis

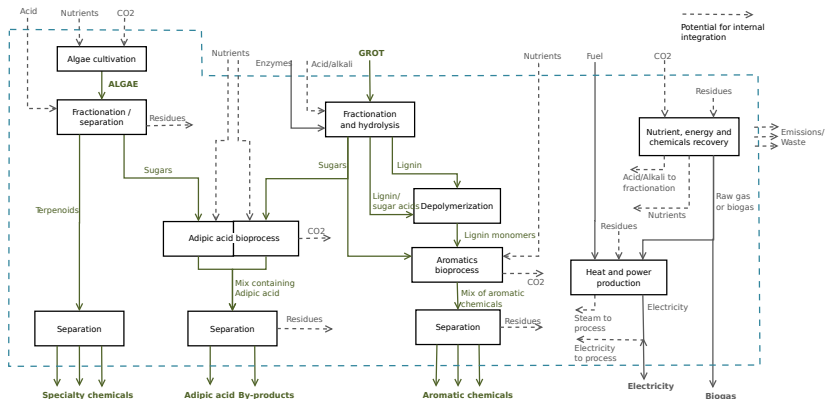
Fossil-based production of adipic acid

■ Traditional production from fossil resources → KA oil¹

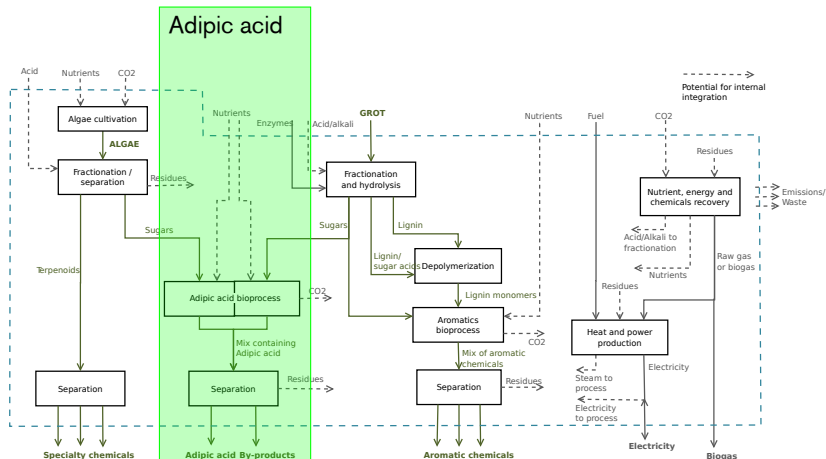


¹ A. Shimizu, K. Tanaka, and M. Fujimori. *Chemosphere Global Change Sci* 2:3-4 (2000), pp. 425–434.

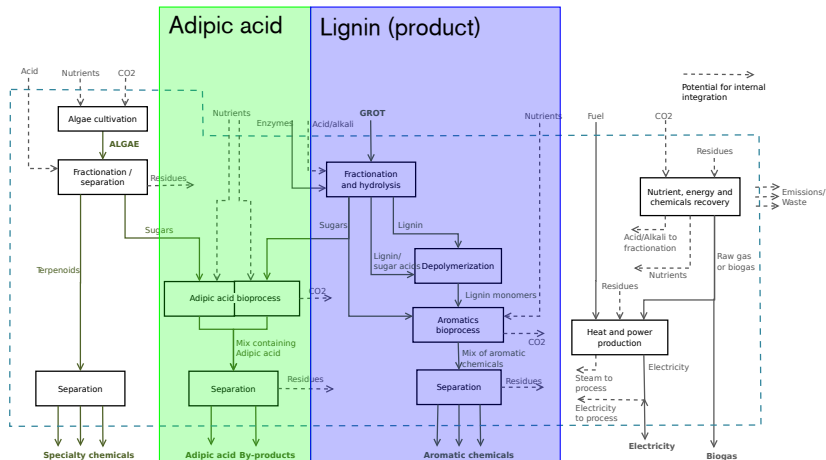
Adipic acid production in a novel biorefinery concept



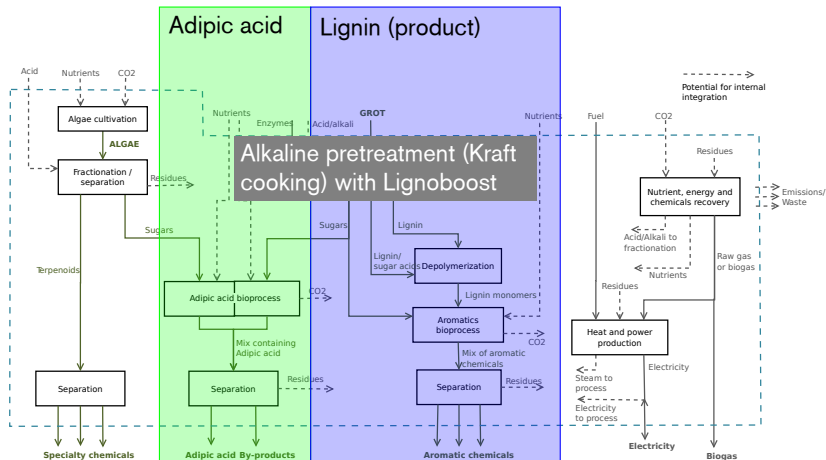
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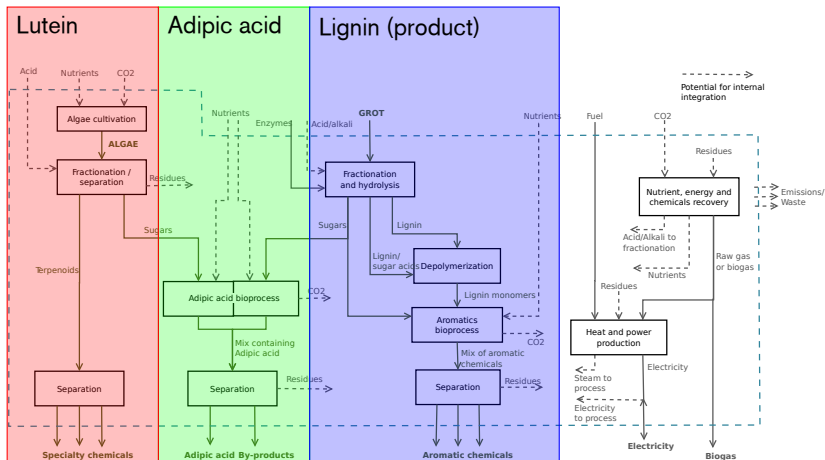
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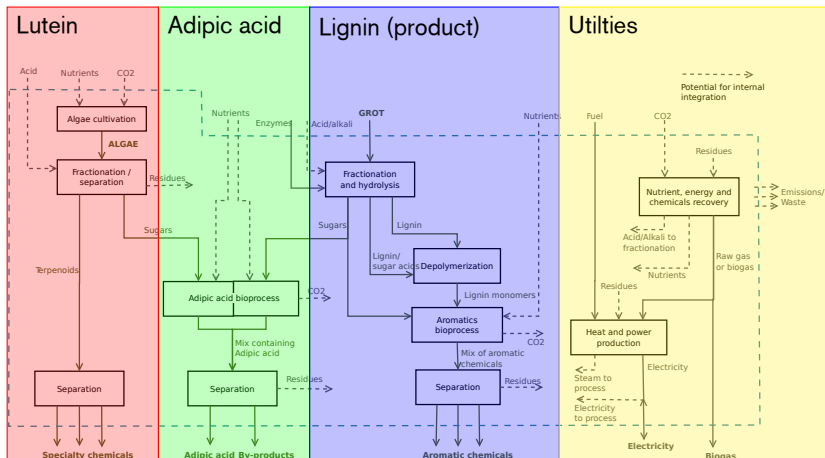
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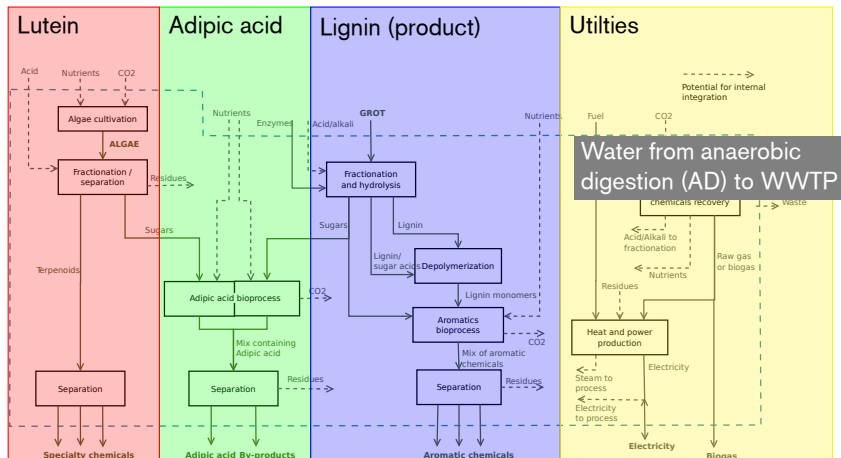
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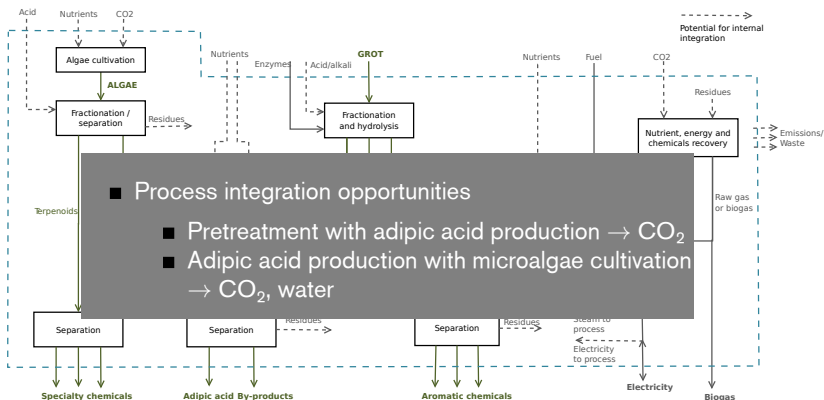
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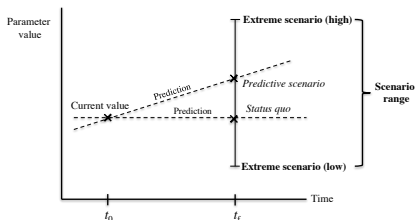
Applying prospective life cycle assessment

- Appropriate methodological choices need to be made²
 - Technology alternatives
 - Foreground system
 - Background system

²R. Arvidsson et al. *J Ind Ecol* 22 (2018), pp. 1286–1294.

Applying prospective life cycle assessment

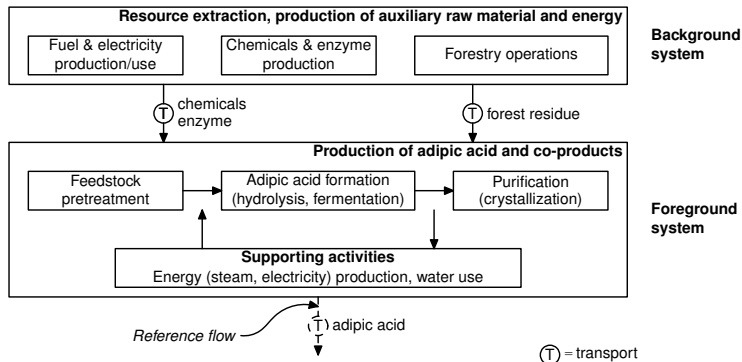
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- Predictive scenarios → Based on forecasts or trends
- Scenario ranges → Illustrate potential environmental impact

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Life cycle assessment

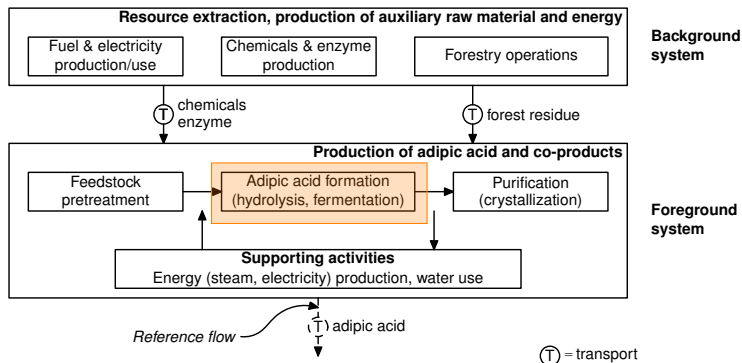


■ Goals

- Guiding technology development
- Future environmental performance of the concept

■ Functional unit → 10 000 t of adipic acid produced

Life cycle assessment

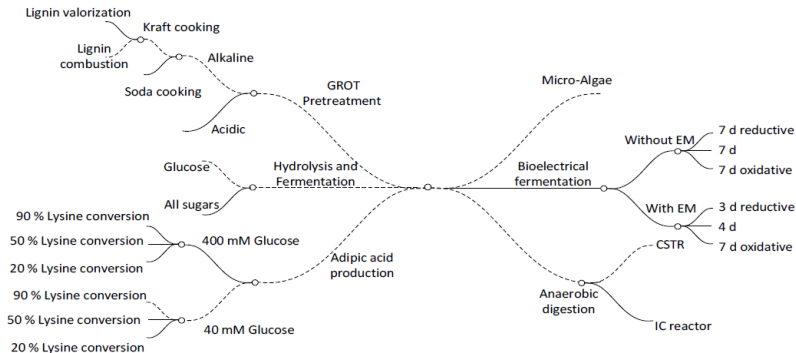


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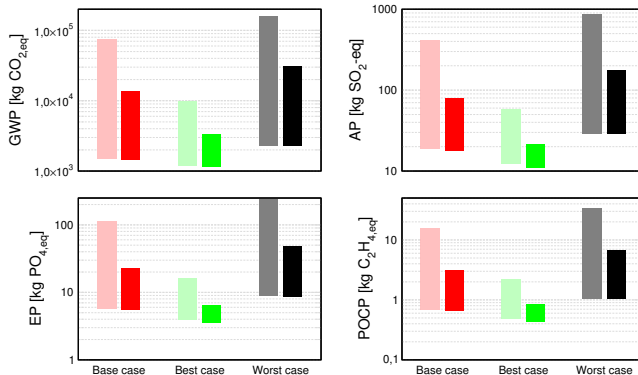
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Construction of process alternatives



- 24 alternatives were constructed for the assessment
 - Lysine conversion → 20 %, 50 % and 90 %
 - Sugar concentration → 40 mM and 400 mM
 - Sugar conversion → Only glucose, all sugars
 - Anaerobic digestion → conventional AD, IC reactor

Ranges of environmental impacts



Semi-transparent bars:
Conventional AD

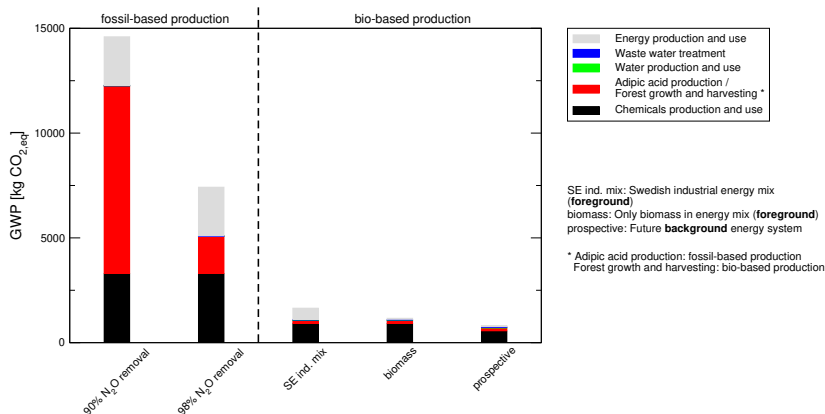
Solid bars:
Internal circulation AD

■ Variation due to

- Heating and cooling demand of the alternative
- Foreground energy system
- Design of the AD

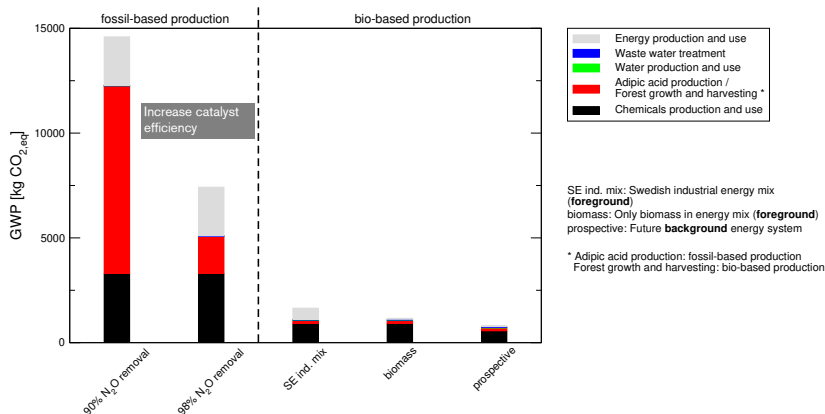
Improvements in climate impact

From fossil-based to bio-based production (best case, minimum heat demand, IC AD)



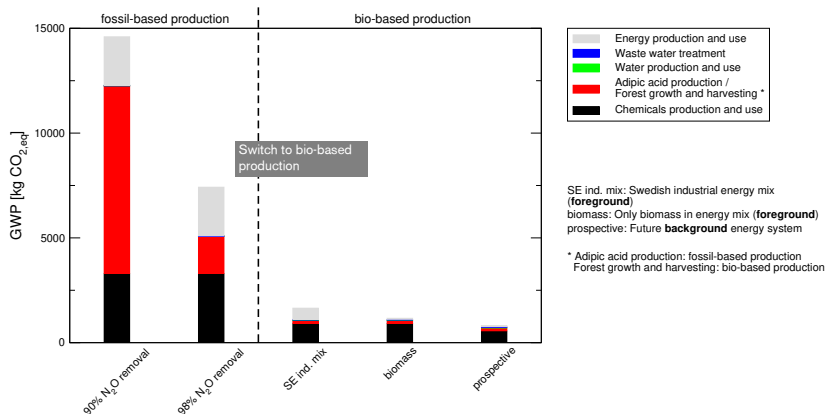
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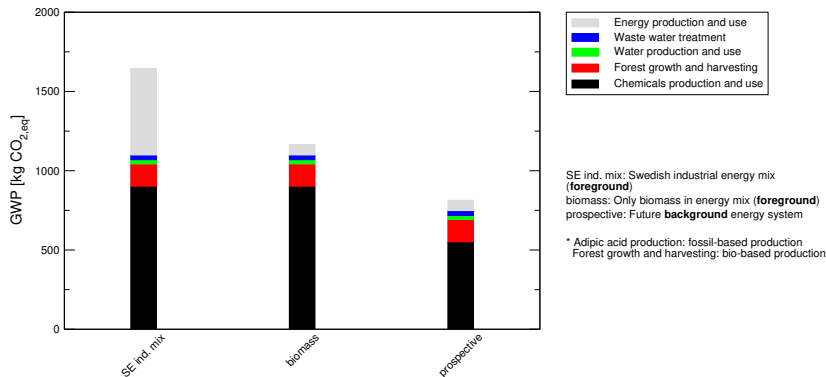
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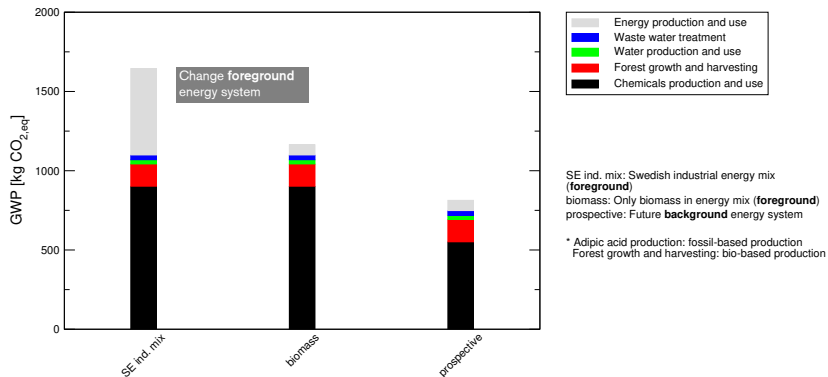
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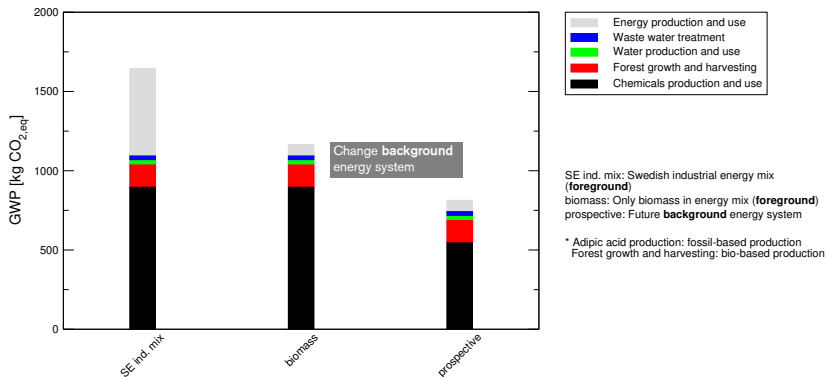
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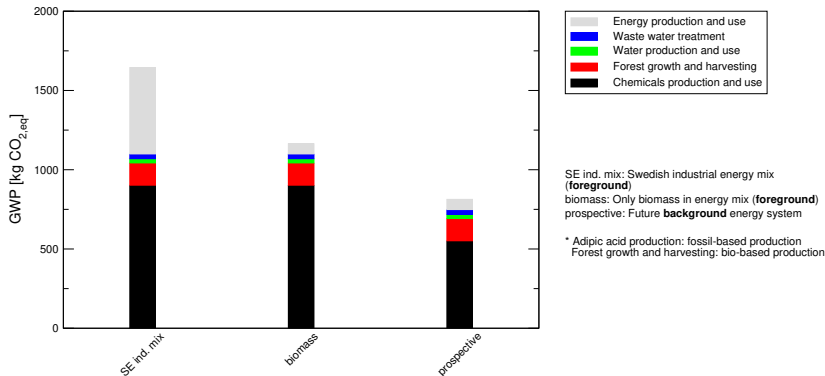
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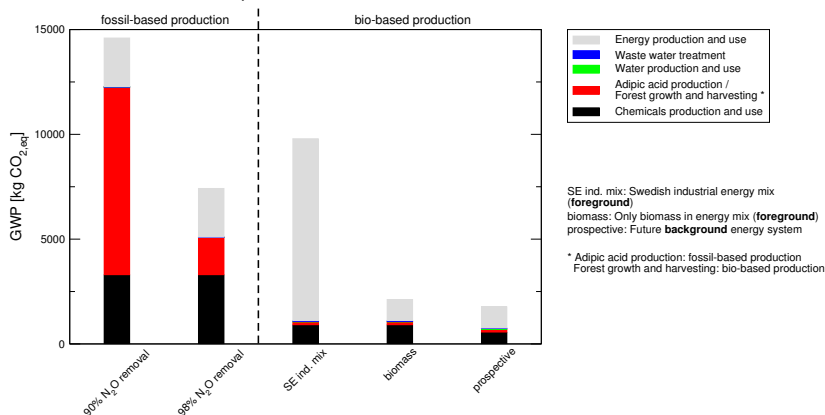
Bio-based production (best case, minimum heat demand, IC AD)



- Further improvements are possible
- Change in background energy system mainly affects chemicals production

Improvements in climate impact

From fossil-based to bio-based production (best case, maximum heat demand, conventional AD)



- Fossil-based production might be the better option
- Clean foreground energy system is crucial

Conclusion

■ Technology

- Switch to bio-based production of adipic acid can lower environmental impacts significantly
- Clean foreground energy system and choice of technology is important
- Future changes in the background energy system may improve chemicals production and use

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■ Methodology

- Inventory data generated with detailed process simulation
- Construction of process alternatives helps identify process and environmental risks
- Changes in background energy system need to be facilitated

THANK YOU

Any questions?